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SCIENCE TRENDS

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TRENDS IN THE MAKING

AEC Laboratories: Strong support for the Atomic Energy Commission's National or "multi-purpose" laboratories comes from Dr. Warren C. Johnson, Chairman of the Commission's influential General Advisory Committee. Johnson is seeking to offset the trickling of critical comments which have started to come from some Congressional, industrial and University sources. But it is admitted that it will be difficult to keep these facilities young and vigorous in the years to come. The fear is expressed that large organizations, particularly those affiliated with the Government, tend to become less effective over a period of time.

ARPA Leadership: Appointment of a scientist to head the embattled Advanced Research Projects Agency at the Pentagon is applauded here by those who have long called for more technical leadership of technical programs. However, at least one Congressional group is now seizing upon the appointment of Dr. Charles L. Critchfield to renew the fight over employment of industrial figures in policy-making posts, with its overtones of possible dual loyalties and conflict of interest. Dr. Critchfield, according to the Pentagon, will be "on leave" from his position with the Convair Division of General Dynamics Corp. According to present plans, he will continue to draw his salary from Convair, serving the Government without additional compensation.

Space Secrecy: The National Aeronautics and Space Administration faces critical inquiries from at least two Congressional investigating committees for withholding non-classified information on research projects (SCIENCE TRENDS, Nov. 2, 1959). Meanwhile, the agency continues to issue cryptic announcements on contracts. Typical was the statement of the past week that Thiokol Chemical Corp. will work on "Spherical Rocket Motors for Re-Entry Research" with no further explanation. While closely guarding the secrecy of supposedly non-secret projects NASA officials are free to bewilder an already-confused American public with a variety of space travel dreams--such as those planned for presentation before the American Rocket Society in Washington in the next few days.

Air-Launched Satellites: Navy has confirmed a report here (SCIENCE TRENDS Nov. 2, 1959) that an attempt was made to launch a satellite from a jet interceptor last year but describes the project as "not successful." Navy also says it does not plan to "conduct further experiments to place a satellite in orbit by means of an air-launch." The report here that some Navy experts believe a satellite orbit was achieved and that future program calls for launching of 180-pound payloads as satellites or satel-
loids is correct.

Flight Vehicle Power

Here is a summary of Air Force thinking on the question of power supplies for future air/space applications. These appraisals were made by Col. R.A. Jones, and J.S. Keeler, of the Power Division, Aeronautical Accessories Laboratory, Wright Air Development Center, Wright Patterson Air Force Base, Ohio:

- * Batteries: Theoretical limits in storage capacities have by no means been approached but further rapid gains are not anticipated. Major emphasis is placed on secondary or rechargeable battery development since solar power system weights hinge on the weight needed for storage to handle peak load and darkness operation requirements.

In particular, the need is expressed for improvement of the deep discharge and re-charge cycling capability for long-duration flights. A ten fold increase is said to be possible.

- * Fuel Cells: Theoretical high efficiencies of these devices have not yet been reached and life-times and reliabilities have been disappointing. However, the system is particularly interesting because of the possibility of regeneration. If reaction products can be successfully dissociated or regenerated by the use of solar or nuclear energy, then large amounts of fuel need not be stored and the system would attain long-duration capabilities.

- * Chemical Dynamic Systems: Space power requirements are expected to be fairly high for boost-glide vehicles now planned, but fairly lower -- on the order of 1/2 to 5 kw -- for short term satellites. Of the dynamic energy conversion systems, turbines are expected to occupy the higher range exclusively, while positive displacement reciprocating devices will be important for the lower requirements.

A great deal of development effort -- particularly in reliability -- is said to lie ahead for both devices. "Realistic goals" are said to include unattended operation under zero gravity conditions for periods of 25 to 300 hours with fuel consumptions of less than 1 lb/HP-hour.

- * Nuclear Power Systems: Extensive work on isotope power systems "does not now appear to be warranted" for Air Force applications according to this estimate. Possible advantages for low-power applications are said to be outweighed by high cost, relative short duration at best system efficiency and potential hazards. Restricting isotope use to high energy orbits and interplanetary probes would eliminate re-entry dangers but the use of higher power systems for these applications appears necessary.

Because of weight considerations the "trade-off point" between nuclear and solar dynamic systems is said to be around 30 kw. It is suggested that nuclear reactor energy conversion system development should therefore be pointed toward units above this in size, with goals of system weights in the order of 15 to 75 pounds per KW depending upon size.

- * Solar Power Systems: Solar systems are expected to supply many, and perhaps the majority, of the long-duration flight vehicle power requirements in the 1965-70 period. Solar dynamic systems are expected to be the optimum in the 5-30 kw range, and may even give nuclear devices "stiff competition" up to 100 kw.

Problems to be solved include reliability and durability for lifetimes of a year or more -- requiring the solution of corrosion and erosion problems associated with the circulating fluid and the development of hydrostatic and hydrodynamic bearings utilizing the working fluid as a lubricating medium. A single rotating assembly and a single working fluid are said to be desirable in the interests of simplicity.

Advances are also needed in solar Collectors, boilers and heat exchangers, energy storage both electrical and thermal, generators, radiators, voltage and speed controls and orientation devices.

Energy Conversion Techniques are of prime importance in future plans. Among these, photovoltaic solar cell arrays are most highly developed. However, it is considered likely that even with anticipated 50 percent improvements in cell efficiency and a likely reduction in weight, the weight and cost of such systems will leave much to be desired. The photo-emission process now under development may eventually be less expensive and simpler although "highly speculative" at this time. One possible advantage is tolerance of orientation errors -- misalignment with respect to incident rays.

Thermoelectric conversion is said to rank slightly above photovoltaic conversion in theoretical efficiency, while being compatible with nuclear and chemical as well as solar heat sources. It is expected that within a decade overall conversion efficiencies of 10 to 12 percent, and a power output of 50 watt per pound in kilowatt sizes may be possible.

Solar Thermionic Conversion could become competitive in efficiency and weight with more conventional rotating machinery, it is suggested, if continuing research proves successful. These devices have a theoretical maximum efficiency of 35 percent and may use any energy source to heat the required cathode. Work is said to be particularly needed on the reduction of the so-called space charge effect between cathode and anode.

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* Engineering Education

Survey by the U.S. Office of Education indicates that the number of Master's degrees awarded in engineering in the U.S. increased 16 percent during the 1958-59 Academic Year. This was substantially higher than advance estimates.

Two other bright signs: a higher percentage of engineering Seniors obtained their Bachelor's degrees than at any time since 1934 and new engineering students at colleges and universities, although fewer in number by 11 percent, generally have higher scholastic records -- indicating that a larger percentage than usual will obtain degrees.

Ocean Surveillance System

A broad-ocean surveillance system is said to be the most critical future need of the Navy in its anti-submarine warfare planning. Assistant Director of Defense Research and Engineering Frank A. Parker believes such a system could solve the problem of initial submarine detection.

Problem: "The detection problem is perhaps the most perplexing one we have," Parker declares, "and it is now complicated by the ballistic missile submarine. In past submarine warfare, the submarine always had to expose itself by firing at short range or by exposing its periscope whenever it made an attack against a convoy or naval force. In this way, initial detection and localization was made.

"The missile-carrying submarine, however, can be expected to deliberately avoid all contacts with counter forces and to simply wait until all is clear before its missiles are fired.

Solution: "An effective ocean surveillance system would permit us to know just where such a submarine is at all times so that we could deploy forces over it, keeping it under constant watch, and, if necessary, destroying the submarine or shooting down its missiles on the rise.

Broad ocean surveillance is also important in conventional submarine warfare, for if we know the areas in which a submarine is operating we can deploy naval forces against it or, where no forces are available, re-route our surface ships to by-pass the area."

Other Problems and Projects:

Magnetic Anomaly: A "fresh look" at the techniques for detection of the magnetic anomaly produced by the steel hull of a submarine in the earth's magnetic field may help in the pinpointing of enemy forces.

Surface Effects: New detection methods may result from improved understanding of the microscopic or macroscopic surface effects produced by a submarine in motion. These include turbulence and perhaps measurable rise of the surface of the ocean directly above the submarine. Photographic, infrared or possibly radar techniques might be adapted to detection of such effects.

Anti-Submarine Torpedoes: Capabilities in both speed and search of acoustical homing torpedoes must be improved. However, faster torpedoes must still have sufficient quietness to permit homing. The problem is said to be particularly difficult because fast torpedoes generate more noise through their machinery and propellers as well as through high-speed hydrodynamic flow.

Target Signal Processing: Much more research is said to be required in the processing of target signals at great distances under low signal to noise ratios. Correlation techniques and digital computers have enhanced signal processing considerably but signals are frequently in a noise background that fluctuates in a manner that does not respond to the "usual simplified statistics."

Basic ocean research is also required for all phases of anti-submarine warfare from early detection through to destruction. Studies of temperature variations, pressure, surface-layer channeling and various ocean "noises" are among the priority projects.

Research Checklist

- () Reactive Metal Processing: Air Material Command has ordered construction by Mallory-Sharon Metals Corp. of a prototype cold crucible for induction melting of reactive metals such as titanium. Studies at Battelle Memorial Institute are said to have demonstrated technical feasibility of the process as well as advantages in production flexibility, labor costs and quality control. A special segmented copper crucible was designed for operation without detectable contamination in laboratory tests.
- (R&D directed by George H. Schippereit, Battelle Memorial Institute, 505 King Avenue, Columbus 1, Ohio)
- () Underwater Radio Propagation: Navy researchers have calculated the effects of the dielectric constant in studies of the characteristics of underwater radio propagation for subsurface communication systems. Universal curves have been derived which are said to be applicable to sea water and any non-magnetic media. The findings are reported to have greatly simplified equations for calculating the rate of attenuation.
- (Report to be published in the near future as NRL Report 5381, by the Naval Research Laboratory, Radio Division, Radio Techniques Branch, Washington 25, D.C.)
- () Ferrites for Microwave Applications: Studies at Harvard University for the A.F. Cambridge Research Center have demonstrated procedures to be used for the preparation of low-loss, high density nickel ferrite for microwave applications. The effects on microwave properties resulting from mixing with other ferrites have also been determined, and a step-by-step discussion of the general method for preparing ferrites is presented.
- (Report Available. 65 pages. \$1.50. Write OTS, U.S. Department of Commerce, Washington 25, D.C. for PB 151 020)
- () Gaseous Scintillation Counter: Research for the Atomic Energy Commission has resulted in development of a gaseous excitation counter said to be capable of detecting the presence and measuring the energy of subatomic particles and electromagnetic radiation. An ultra-violet light is produced which strikes a fluorescent material within a counter, to produce visible excitation.
- (For information on royalty-free patent licensing write Assistant General Counsel for Patents, U.S. Atomic Energy Commission, Washington 25, D.C. regarding Patent No. 2,884,529)
- () Chemical Reaction Research: Studies at the National Bureau of Standards have led to development of a simple method for observation of certain low-activation-energy reactions which take place at very low temperatures. The technique is said to open new fields of inquiry into chemical behavior, particularly the mechanisms and kinetics of elementary reactions.
- (Report Available. Single Copies Free. Write National Bureau of Standards, Office of Technical Information, Washington 25, D.C. for Studies of Reactions With Low Activation Energies)

Publication Checklist

- () Boron High Energy Fuels, the transcript of a Congressional Hearing into the causes of Defense Department cancellation of contracts for development of boron fuels. 137 pages. Single copies free. (Write Committee on Science and Astronautics, George Washington Inn, Washington 25, D.C. for Hearing No. 40)
- () Fast Electrons, tabulations of the energy dissipated by fast electrons at different distances from plane perpendicular and point isotropic sources. The publication also summarizes the theoretical methods and data utilized in the tabulations and presents a table of spatial moments. 70 pages. 45 cents. (Write Superintendent of Documents, Government Printing Office, Washington 25, D.C., for Pub. No. C 13.44:1)
- () Communications-Electronics Terminology, a 1959 Air Force manual designed to provide a complete cross-reference listing of terms, nicknames, designations, abbreviations and definitions used in military communications and electronics, including the field of astronautics. In addition, the volume provides definitions of words not directly pertaining to military communications or electronics. 857 pages. \$3.50. (Write Service Department, Washington Science Trends, 1120 National Press Building, Washington 4, D.C.)
- () Space Materials, the proceedings of a 1958 ordnance materials research conference dealing with the problems of materials in the space environments encountered by space vehicles or orbiting satellites. Among the topics were the physics of space vacuum and effects on materials, thermal problems, radiation and radiation effects, meteorites and cosmic dust. 276 pages. \$4. (Write OTS, U.S. Department of Commerce, Washington 25, D.C., for PB 151 900)
- () Re-entry Ablation, an industrial compilation of various papers from trade and technical journals dealing with reinforced plastics and their behavior at very high temperatures. 43 pages. Free. (Write to Product Information, GE Missile and Space Vehicle Department, 3198 Chestnut Street, Philadelphia, Pa., for PIB-15)
- () Ceramics and Refractories, a catalog of technical reports available for purchase dealing with ceramic, enamel and refractory coatings and the high-temperature and electrical properties of ceramics. Reports cover the period 1930 - 1959. 21 pages. 10 cents. (Write OTS, U.S. Department of Commerce, Washington 25, D.C. for CTR -373)
- () Science and Technology - Africa, a significant report on ways and means of strengthening science and technology in selected areas of Africa South of the Sahara. 130 pages. Single copies free. (Write Mr. Eric R. Rude, Office of International Relations, National Academy of Sciences, 2101 Constitution Avenue, N.W., Washington 25, D.C.)
- () Zirconium-Hafnium Separation, a report on 33 months of operation of an Albany, Ore., plant designed to produce low-hafnium zirconium and low-zirconium hafnium oxide. 22 pages. Single copies free. (Write Publications-Distribution Section, U.S. Bureau of Mines, 4800 Forbes Avenue, Pittsburgh 13, Pa. for Report of Investigation No. 5499)

